Effect of corylus clusters on the physicochemical properties of soil

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Abstract: Soil sample plots were specified and the soil in layer A_0, A_1 and AB were collected in Maoershan-Forest Experiment Farm of Northeast Forestry University for study of the effect of corylus clusters on soil in 1999. The result shows that the pH value, contents of organic matter, total nitrogen, alkali-discomposed nitrogen and total phosphorus under the corylus clusters are higher than that under the non-corylus clusters, except the available phosphorus content. The number of soil granular aggregates or the water stable aggregates under corylus clusters is more than that under the non-corylus clusters. The corylus clusters play an important role in improving the physicochemical properties of the soil, which should be conserved and developed in the forestry production.
Key words: Corylus cluster; Soil physicochemical properties
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Introduction

The corylus is one of the important shrub species in the Northeast of China, which has a high economic value as oil material or food. The corylus is usually the dominant shrub species in some forest types and plays an important part in ameliorating the physical and chemical properties of the soil in that its roots are well developed in comparison with other kinds of shrub species. Sometimes the soil under the corylus clusters is applied to the nurseries to improve soil fertility (Zhou 1986). It's important to discern why the soil under the corylus is more fertile, which may help explain nutrient cycling of forest ecosystem, increase of forest productivity and the reasonable utilization of shrub resources.

Materials and methods

The research site is located in Maoershan Forest Experiment Farm of Northeast Forestry University, (127°30'~127°34' E, 45°20'~45°25' N). The annual average temperature in this area is 2.8 °C. Annual average precipitations and evaporation are 723.7 mm and 1 093.9 mm respectively. Frost-free period is 120-140 d. Forest type belongs to secondary natural forest and the zonal soil is dark brown forest earth.

11 soil sample plots were specified under the corylus clusters and the soil samples in the layer of A_0, A_1, AB were collected respectively. The contrasted soil samples under the non-coryllus clusters were collected near the corylus clusters. Simultaneously, the fresh and dead leaves of the corylus and non-corylus clusters were also collected. The soil pH and nutrients were measured according to the standard methods issued by the State Standard Bureau (The State Standard Bureau 1988).

Results and discussion

Effect on soil pH

The soil pH value under the corylus clusters is 0.2~1.4 higher than under the non-corylus clusters (Table 1). The main reasons may be that the leaf of the corylus is larger and softer, and there is a larger litter amount under the corylus clusters in comparison with the non-corylus clusters. Moreover, the corylus litter contains richer mineral elements and its mineralization speed is faster. In consequence, the soil base amounts under the corylus clusters increase and the soil acidity is neutralized.

Effect on soil organic matter content

The organic matter content of soil is one of the important indexes was used in evaluating soil fertility, which affects the soil nutrient contents, structure and some other physiochemical properties. By experiments, we can concluded that the organic matter

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under the corylus clusters is 13%~287% higher than that under the contrasted shrubs (Table 2).

Table 1. The soil pH value under the corylus and non-corylus clusters

Items	Sample plot	Sample No										
		1	2	3	4	5	6	7	8	9	10	11
PH (in water)	corylus	6.02	6.14	5.84	5.85	5.43	5.56	6.31	6.00	6.05	6.12	6.32
	non-corylus	4.99	5.48	5.59	5.43	5.13	5.16	5.79	5.40	5.40	5.57	5.10
PH (in salt solution)	corulus	5.61	5.74	5.34	5.15	4.80	4.89	5.70	5.46	5.80	5.61	5.80
	non-corylus	4.38	4.74	5.10	4.68	4.58	4.57	5.49	4.78	4.89	5.05	4.40

The soil organic matter content is directly affected by the amount, type and characteristics of the litter on the surface soil layer. The leaves of the corylus are larger and the amount of its withered leaves are much more than that of non-corylus. The A_0 layer under the corylus clusters is 1~2 cm thicker than that under the non-corylus clusters. Moreover, the desirable soil acidity under the corylus clusters promotes the activities of bacteria and some other kinds of microorganisms, which accelerate the humus-forming process. As a result, the soil organic matter content increased under the corylus clusters.

Effect on soil total nitrogen content

The soil total nitrogen content under the corylus clusters is 13%~121% higher than under the non-corylus clusters. The reason may be that the soil under the corylus clusters is richer in organic matter which is closely related to the content of the total nitrogen, at the same time, the nitrogen content of corylus leaves is higher than that of other kinds of shrubs, which may also be one of the reasons.

Table 2. The contents of the organic matter, total and alkali-decomposed nitrogen under the corylus and non-corylus clusters

Items	Sample plot	Sample No.										
		1	2	3	4	5	6	7	8	9	10	11
Organic matter/%	corylus	18.4	14.4	16.8	14.7	17.0	21.5	18.0	16.4	16.4	19.3	17.0
	non-corylus	10.1	8.5	9.02	6.3	3.9	10.8	13.9	14.5	12.4	10.9	15.1
Total nitrogen/%	corylus	0.84	0.67	0.76	0.68	0.74	0.99	0.78	0.75	0.74	0.94	0.77
	non-corylus	0.46	0.41	0.43	0.31	0.39	0.53	0.63	0.67	0.57	0.53	0.68
Alkali-decomposed	corylus	1122	1179	1157	945	1047	952	820	1237	937	1232	1148
Nitrogen/mg.kg^{-1}	non-corylus	936	875	672	906	863	841	675	1154	740	1051	1077

Effect on soil alkali-decomposed nitrogen contents

Alkali-decomposed nitrogen as available nitrogen can be utilized by the plants during a short period. The soil alkali-decomposed nitrogen contents under corylus clusters are obviously higher than that under the non-corylus clusters (Table 2). To explain this kind of phenomenon is that the rich total nitrogen can provide nitrogen resource for formation of alkali-decomposed nitrogen. Another reason may be that the soil pH value under the corylus is higher than that under other kinds of shrubs and nearly neutral. Meanwhile the protoplasm pH value of most microorganisms is also approximately neutral, and most soil microorganisms are more active under the neutral pH value condition, which results in more alkali-decomposed nitrogen being produced.

Effect on soil phosphorus content

The element phosphorus has an indispensable action to the plant growth as one of the essential elements used by the plants. Soil total phosphorus contents under corylus clusters are higher than under the non-corylus clusters, whereas the soil available phosphorus content is much lower under the corylus clusters (Table 3). The phosphorus content of the fresh corylus leaves is always changeable with seasons, either higher or lower than some other kinds of shrubs, just because the element phosphorus is always involved in all the metabolisms (Wu 1993). The corylus leaf samples were collected in June when the metabolism is extremely active and large quantities of nutrient are consumed, so the phosphorus content of the corylus leaves is very low, compared with other metabolic periods. But the average phosphorus content of the corylus leaves may be higher than that of other shrub species despite the specific content in some stage. The number of the withered leaves, on the other hand, under the corylus clusters is much more than that under other shrubs. Consequently, under the same other conditions, the soil total phosphorus content under the corylus clusters is higher than that under the non-corylus clusters by decomposition of dead leaves.

Table 3. The contents of the total and soluble phosphorus under the corylus and non-corylus clusters

Items	Sample plot	Sample No.										
		1	2	3	4	5	6	7	8	9	10	11
Total phosphorus /%	corylus	0.33	0.26	0.27	0.27	0.39	0.33	0.34	0.35	0.28	0.35	0.29
	non-corylus	0.27	0.18	0.20	0.22	0.32	0.23	0.25	0.34	0.27	0.33	0.25
Soluble phosphorus /%	corylus	17.3	22.0	20.0	23.7	15.9	16.8	36.5	13.9	15.6	13.7	15.4
	non-corylus	27.0	25.3	24.1	38.4	39.2	22.3	48.1	36.0	21.2	36.2	30.4

The soil available phosphorus content is unstable, and it changes with seasons and is affected by some kinds of cations such as Ca^{2+} and Mg^{2+} (Peng 1994). The mineralization rate of corylus leaves is faster, and the soluble phosphorus is elluviated to A_1 layer, where most roots distribute. The roots of corylus are still not well developed at the sampling time, and large quantities of cations such as Ca^{2+} and Mg^{2+}, which cannot be absorbed in time, promoted the formation of insoluble phosphorus. In contrast with this, the decomposition rate of other shrubs' leaves is slower and their roots are active by sampling time, which leaves fewer cations such as Ca^{2+} and Mg^{2+} and retards the fixation of the soluble phosphorus. As a result, the available phosphorus content under non-corylus clusters is much higher than that under the corylus clusters.

Effect on soil structure

Content and stability of soil aggregate is also one of the indexes used in evaluating soil fertility. The results of various water stable aggregates in soil under the corylus clusters and non-corylus clusters are given in Table 4.

Table 4. The results of the various water stable aggregate under the corylus and non-corylus clusters

Sample No.	Sample plot	Content of water stable aggregate /%				Percentage of water stable aggregate in total			
		>5 /mm	5~1/mm	1~0.25 /mm	Total	>5 /mm	5~1 /mm	1~0.5 /mm	Total
1	corylus	1.62	29.59	22.04	53.25	3.04	55.56	32.09	90.69
	non- corylus	3.51	22.74	20.70	46.95	7.48	48.43	33.12	89.03
2	corylus	9.78	41.28	14.04	64.99	15.03	63.37	16.57	94.97
	non- corylus	4.19	24.98	17.45	46.62	8.99	53.58	32.67	95.24
3	corylus	4.30	43.40	16.70	64.40	6.68	67.39	20.14	94.21
	non- corylus	1.49	37.93	20.36	59.78	2.49	63.45	26.93	92.87
4	corylus	2.34	32.85	20.64	55.83	4.19	58.84	34.23	97.26
	non- corylus	3.87	33.76	18.00	55.63	6.96	60.69	26.87	94.52
5	corylus	5.86	35.38	25.98	67.22	8.72	52.64	30.59	91.95
	non- corylus	3.16	26.78	16.07	46.01	6.87	58.21	22.39	87.47
6	corylus	6.51	36.43	23.20	66.14	9.84	55.08	26.05	90.97
	non- corylus	4.37	29.52	17.49	51.38	8.51	57.45	19.75	85.71
7	corylus	2.42	43.32	18.20	63.94	3.79	68.05	20.64	92.18
	non- corylus	2.86	22.48	19.87	45.21	6.33	49.73	38.88	94.94
8	corylus	1.50	38.54	30.24	70.28	2.13	54.84	32.17	89.14
	non- corylus	1.53	33.33	21.82	56.68	2.70	58.82	32.92	94.44
9	corylus	1.05	40.01	24.95	66.01	1.59	60.61	38.60	87.65
	non- corylus	1.47	29.17	31.82	62.46	2.35	46.70	32.09	94.05
10	corylus	1.10	47.90	27.14	76.14	1.45	62.91	31.00	95.35
	non- corylus	2.52	43.57	26.41	72.50	3.48	60.09	28.99	92.56
11	corylus	5.97	29.51	16.38	51.86	11.51	56.90	26.82	95.23
	non- corylus	7.68	25.41	16.43	49.52	15.51	51.31	28.13	94.95

The percentage and contents of various kinds of water stable aggregate in total aggregate and in total water stable aggregate under the corylus clusters are obviously higher than that under non-corylus clusters. It can be said that both quantity and quality of soil aggregate under corylus clusters are better than that under the non-corylus clusters. Three reasons for why the soil structure under corylus clusters are better. Firstly, there is more humus in the soil under the corylus clusters, which is excellent cement for formation of soil aggregate. Secondly, there are large quantities of returned cations such as Ca^{2+} and Mg^{2+}, which is an important factor for aggregation of soil particles. Lastly, the roots of the corylus have a strong penetrative ability in soil to promote formation of soil aggregates.

Conclusion and suggestion

The soil pH value under the corylus clusters is greater than that under the non-corylus clusters. The declined acidity is conducive to activities of the microorganisms, which would promote the transition of soil organic matter.

The contents of the soil organic matter, total and alkali-decomposed nitrogen under the corylus clusters are higher than under the non-corylus clusters.

The soil total phosphorus content under the corylus clusters is greater than under the non-corylus clusters. Whereas, the soil available phosphorus is lower under the corylus clusters in the spring, which is closely related to the specific physiological characteristics of the corylus.

The corylus is one of the excellent shrub species that can improve the soil fertility by promoting the formation of soil water stable aggregate.

The corylus should be viewed as an important shrub species, which can improve the soil fertility, and be conserved and developed in the forestry production.

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